

Response under 37 C.F.R. §1.116
Serial No. 10/720,700
Attorney Docket No. 032134

REMARKS

Claims 1-18 are pending in the present application. Claims 1-8 and 10 are rejected. Claims 1, 4, 8 and 10 are herein amended. Claims 11-18 have been added. No new matter has been entered.

Applicants herein amend claims 1 and 8 to clarify the invention, and add new claims 11-18. Applicants note that the amendment of claim 1 substantially returns claim 1 to its previously pending condition, removing limitations directed to (a) the surface of the nickel hydroxide is coated with a cobalt compound; and (b) the cobalt compound is a higher-order cobalt compound which has distorted crystal structure and contains alkali cations with the clarification of the possible positive electrode constituents, which were inadvertently added to claim 1 but never removed from claims 2 and 3, respectively.

The Amendment to claim 4 corrects its dependency.

The Amendment to claim 8 further limits the possible positive electrode constituents.

The amendment to claim 10 merely corrects its dependency from canceled claim 9 to claim 8.

New claims 11-18 are substantially similar to the pending claims; Applicants submit that this does not require the Examiner's additional search, and request entry thereof.

Claim Rejections - 35 U.S.C. §103(a)

Claims 1-10 are rejected under 35 U.S.C. §103(a) as being unpatentable over Kohno et al. 6130006 view of the Japanese publication JP 10-261412.

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The Examiner characterizes that present application as being geared toward a nickel-hydrogen secondary battery wherein the disclosed inventive concept comprises the specific hydrogen-absorbing alloy.

With respect to claims 4-6, the Examiner asserts that the positive electrode of Kohno et al. may also contain at least one oxide or hydroxide of metal selected from the group consisting of zinc and cobalt (column 32, lines 49-62). The Examiner reasons that because Kohno et al. disclose that conductive materials can be added to the nickel hydroxide, the average valency behavior of the nickel contained in the nickel hydroxide (i.e., higher than 2) is an inherent characteristic thereof because of the addition of more conductive material, specifically Co, which the Examiner asserts tends to alter valency upon interaction with Ni, and further because during charging and discharging cycles the nickel hydroxide takes transitional states for electrochemical reaction purposes.

With respect to the cobalt compound coated on the nickel hydroxide, the Examiner concludes that it would have been obvious to use a cobalt compound coating on the nickel hydroxide of the positive electrode of Kohno et al. as taught by the JP '412 because the JP '412 discloses that positive electrodes including such a coating material is excellent in utilization factor of nickel hydroxide under atmosphere ranging from an ordinary temperature to a high temperature. Thus, the cobalt-based layer on the Ni-hydroxide electrode material complements a better utilization of that electrode material.

Applicants herein amend claims 1 and 8 to clarify the invention. Thereafter, Applicants respectfully submit that the claims, as amended, overcome the rejections for the following reasons.

With respect to the prior art, Applicants note that a nickel-hydrogen secondary battery using any of the positive electrodes disclosed in Unexamined Japanese Patent Publication No. Hei 10-261412 has a problem that the continuous charging characteristic, namely the characteristic that the battery shows when charged continuously or continually for a long time is not at a satisfactory level. This problem comes about because the additive including metallic yttrium or the like makes the oxygen generating potential of the positive electrode higher. Hence, when the battery is charged, charging reaction of nickel hydroxide goes on at high charging efficiency. Due to this high charging efficiency, when the battery is charged continuously or continually for a long time, the charging range of the positive electrode extends over a beta nickel oxyhydroxide generating range up to a gamma nickel oxyhydroxide generating range, so that gamma nickel oxyhydroxide is generated.

The density of gamma nickel oxyhydroxide is lower than that of beta nickel oxyhydroxide. Hence, when gamma nickel oxyhydroxide is generated at the positive electrode, the positive electrode or the positive electrode active material swells, so that the alkaline electrolyte is absorbed and held in the positive electrode. Consequently, the amount of the alkaline electrolyte which contributes to electrode reaction in the battery decreases relatively. Thus, the battery becomes more difficult to be charged and discharged. In other words, when continuous charging is performed, the capacity of the battery decreases.

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The object of the present invention is to solve the problem that the battery capacity decreases when continuous charging is performed at high temperature (paragraphs [0011]-[0014]).

The above object is achieved by the nickel-hydrogen secondary battery according to claim 1, which is characterized in that the positive electrode contains nickel hydroxide and Nb, and that the negative electrode contains a hydrogen-absorbing alloy having composition represented by a general formula $Ln_{1-x}Mg_x(Ni_{1-y}T_y)_z$.

The nickel-hydrogen secondary battery according to claim 11 is characterized in that the positive electrode contains nickel hydroxide and at least one element selected from the group consisting of Nb_2O_5 , WO_2 and WO_3 , and that the negative electrode contains a hydrogen-absorbing alloy having composition represented by a general formula $Ln_{1-x}Mg_x(Ni_{1-y}T_y)_z$.

With the batteries of claims 1 and 11, the Mg taken in the positive electrode restrains production of gamma nickel oxyhydroxide in continuous charging, and even if gamma nickel oxyhydroxide is produced, it restrains the alkaline electrolyte from being absorbed into the positive electrode (paragraph [0044]). The aforementioned object is fully achieved by making the positive electrode contain Nb or contain at least one of Nb_2O_5 , WO_2 and WO_3 .

Applicants now note the comparison between the present invention and the references. Applicants note that although each of the cited reference are discussed separately, they are not argued separately.

An object of Kohno et al. (US 6,130,006) is to provide an electrode of hydrogen-absorbing alloy capable of readily releasing hydrogen and having a large discharge capacity. To

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achieve the object, the hydrogen-absorbing alloys disclosed in Kohno et al. have respective predetermined compositions.

The object of JP 10-261412 is to provide an alkaline storage nickel positive electrode which is excellent in utilization factor of nickel hydroxide under atmospheres ranging from an ordinary temperature to a high temperature (Abstract). To achieve the object, the nickel positive electrode of JP '412 contains a compound of at least one kind of element selected from the group consisting of Ca, Sr, Ba, Cu, Ag, Cd, Y, Yb, Ce, Sm, Gd and Er. These elements serve to increase the oxygen over voltage during the charging in a high-temperature atmosphere, thereby restraining the generation of oxygen (paragraph [0011])

With respect to differences between the present invention and the cited references, Applicants note that the present invention differs from Kohno et al. and JP '412 in the problem to be solved as well as in the object to be achieved. The object of the present invention is to solve the problem associated with the nickel electrode of JP '412. Neither Kohno et al. or JP '412 suggests the problem solved by the present invention.

To solve the problem, claims 1 and 11 each define a distinguishing construction that is not attained by the combination of Kohno et al. and UP '412. Specifically, according to claim 1, the negative electrode contains a hydrogen-absorbing alloy having the predetermined composition and at the same time the positive electrode contains Nb which is not taught by JP '412. And according to claim 11, the positive electrode contains at least one of Nb₂O₅, WO₂ and WO₃, none of which is taught by JP '412.

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Claims 1 and 11 provide advantages over the cited references, alone and in combination. For instance, in Examples 2 and 9 of the present invention wherein the positive electrode contains Nb_2O_5 and WO_3 , respectively, and x is 0.3 and 0.8, respectively, the continuous-charging life is 102 in both cases. On the other hand, in Examples 4 and 5 in which the positive electrode contains Er_2O_3 and $\text{Ca}(\text{OH})_2$, respectively, both disclosed in JP '412, and x is 0.2 and 0.4, respectively, the continuous-charging life is 100 and 99, respectively.

Thus, in cases where the positive electrode contains a compound of Ca or the like disclosed in JP '412, as in Examples 4 and 5, the continuous-charging life is not satisfactorily improved even if a hydrogen-absorbing alloy having the predetermined composition is used. Also, comparison between Examples 2 and 5 reveals that a high content of Mg in the hydrogen-absorbing alloy does not directly contribute to improving the continuous-charging life. The continuous-charging life can be significantly prolonged when the positive electrode contains Nb or at least one of Nb_2O_5 , WO_2 and WO_3 .

In view of the aforementioned amendments and accompanying remarks, Applicants submit that the claims as herein amended and new claims are in condition for allowance. Applicants request such action at an early date.

If the Examiner believes that this application is not now in condition for allowance, the Examiner is requested to contact Applicants' undersigned attorney to arrange for an interview to expedite the disposition of this case.

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If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,

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